

B5 23. The apparatus of claim 22 wherein the chamber of said laser processing apparatus is provided with a mechanism for moving said substrate in a direction orthogonal to the elongation direction of said laser beam in order that a whole surface of said substrate can be scanned with said laser beam.

24. The apparatus of claim ~~8~~, 16, or ~~21~~ wherein said laser is an excimer laser.

25. The apparatus of claim ~~8~~, 16, or ~~21~~ wherein the wavelength of said laser light is one of 248 nm, 308, nm and 350 nm.--

REMARKS

The Examiner's Official Action dated April 6, 1995 has been received and its contents carefully noted. Claims 8-20 were pending in the application prior to the above amendment and claims 8 and 16 are independent. Claims 9, 10 and 14 have been cancelled. New claims 21-25 have been added and are believed to be allowable as written. Accordingly, claims 8, 11-13, and 15-25 are now pending in the application.

Summary of the Invention

Claims 8, 11-13, and 15-25 are currently pending in the present application. The claims are generally directed to an apparatus for processing a semiconductor provided on a substrate without exposing the semiconductor to air between the formation of the semiconductor layer and the laser process. If the semiconductor layer is exposed to the air before it is processed with a laser light for crystallization, a natural oxide (SiO_2) is formed on the semiconductor layer. During a laser crystallization, the natural oxide reacts with the semiconductor layer so that unstable silicon oxides (which may be expressed by SiO_{2-x}) are formed on the surface of the semiconductor layer. If a gate

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insulating film is formed on the semiconductor layer after the laser crystallization, there are many dangling bonds of silicon atoms at the interface between the semiconductor layer and the gate insulating layer. Accordingly, the characteristics of a semiconductor device using such a structure can not be improved. For the above reason, it is particularly advantageous to conduct a laser process after the formation of a semiconductor layer without exposing the semiconductor layer to air.

Specifically, claim 8 as amended recites a film formation apparatus, a laser processing apparatus, a preliminary chamber and a mechanism for transporting a substrate from the film formation apparatus to the laser processing apparatus through the preliminary chamber without exposing the substrate to air. Claim 16 recites a preliminary chamber connected with a laser processing apparatus, and an ion introducing apparatus wherein a mechanism is used to transport a substrate from the ion introducing apparatus to the laser processing apparatus without exposing the substrate to air. This apparatus allows a substrate to be transported within the chamber to protect it from outside contamination. Newly added claim 21 recites a laser processing apparatus comprising an ion doping apparatus, a first and second preliminary chamber, an etching apparatus, and a laser processing apparatus, wherein the first and second preliminary chamber have a mechanism for transporting a substrate between the respective apparatus.

Prior Art Rejections

The Official Action rejects claims 8-11 and 13 as anticipated by U.S. Patent No. 5,194,398 to Miyachi et al. Miyachi et al. appears to disclose an apparatus comprising a film forming chamber 1 and a dehalogenating-hydrogenating chamber 2 (see Fig. 5) which are combined by a conveying device 13 for moving the substrates between the chambers. The dehalogenating-hydrogenating process is performed using a light irradiation process (see col. 18, lines 29-43).

As noted above, Applicant has amended independent claim 8 to include the



limitation of cancelled dependent claim 14, which recites a preliminary chamber interposed between the film formation apparatus and the laser processing apparatus. It is evident upon reading Miyachi et al. that chambers 1 and 2 (illustrated in Fig. 1) are merely connected by a passage and not a separate chamber as recited and disclosed in the present application. Specifically, the specification of the present application describes the preliminary chamber on page 5, in the two full paragraphs. Essentially, the preliminary chamber 9 is connected to the film formation chamber 1 and the laser processing apparatus 2. Gates are mounted on opposite ends of the preliminary chamber to separate it from the film formation chamber 1 and the laser processing apparatus 2. Hence, the preliminary chamber may be evacuated to a sufficiently high vacuum during semiconductor processing. This feature is absent from the Miyachi et al. reference. In view thereof, reconsideration of the above claims as amended is requested.

The Official Action rejects claim 12 as obvious based on the combination of Miyachi et al. and U.S. Patent No. 4,888,305 to Yamazaki et al. Yamazaki et al. appears to disclose an apparatus for irradiating the interior of a reaction chamber 11 with an excimer laser or the like through a window (see col. 2, lines 38-41).

Applicant has amended claim 12 to recite a laser processing apparatus comprising a chamber having a window through which a laser beam may be introduced into the chamber. Applicant respectfully submits, however, that claim 12 is dependent on claim 8 and therefore, should be allowable for all of the same reasons discussed above in connection with claim 8 with regard to Miyachi et al. In addition, the applicant believes that the Official Action has failed to provide a motivation for one skilled in the art to combine the above-noted prior art references to yield the present invention. Therefore, reconsideration in view of the above arguments is respectfully requested.

The Official Action rejects claims 8 and 14-20 as obvious based on the combination of Miyachi et al., U.S. Patent No. 5,310,410 to Begin et al., U.S. Patent No. 4,937,205 to Nakayama et al., U.S. Patent No. 5,200,017 to Kawasaki et al. and

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U.S. Patent No. 5,292,675 to Codama. Begin et al. appears to disclose an apparatus for processing semiconductor wafers which includes satellite reaction chambers disposed around the periphery of a central chamber which houses a robot assembly for moving a substrate to various positions within the apparatus (see Fig. 1). Nakayama et al. and Kawasaki et al. appear to generally teach plasma doping apparatus and methods. Codama appears to disclose a method for fabricating a TFT using an etching and ion implantation process.

With respect to independent claim 8 as amended, Miyachi et al. discloses a dual chamber design and a method of transporting a substrate between each chamber. However, Miyachi appears to completely fail to disclose or suggest a preliminary chamber, as discussed above, connected between a film formation apparatus and a laser processing apparatus, where the substrate is passed therethrough as recited in claim 8 as amended. Furthermore, none of the other references relied upon by the Official Action appear to overcome this deficiency. Therefore, since this element, clearly recited in claim 8 as amended, is not found in the prior art of record, Applicant respectfully believes that these claims are not obvious in view thereof.

Furthermore, Applicant believes that the Official Action has completely failed to provide a sufficient showing that one of skill in the art would be motivated to combine these references as done in the Official Action. Absent some showing in the prior art that one of skill in the art should combine these references, Applicant believes that the rejection is improper and reconsideration is requested.

With respect to independent claim 16 as amended, Applicant does not believe that any of the cited references disclose or suggest an apparatus having a preliminary chamber with a laser processing apparatus, and an ion introducing apparatus connected thereto. Specifically, Applicant does not believe that the prior art of record discloses or suggests an apparatus for processing a semiconductor as claimed. Also, as discussed above in connection with claim 8, Applicant does not believe that the Official Action has provided

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a sufficient showing of motivation combine these teachings and reconsideration is requested.

In addition to the lack of motivation to combine the prior art references, independent claims 8 and 16 as amended provide the unobvious advantage of conducting a laser process on a semiconductor layer without exposing the semiconductor layer to the air between the formation of the semiconductor layer and the laser process as discussed above.

Formalities

The Official Action rejects claim 20 as indefinite. Specifically, the Official Action rejects the phrase "magic hand" used in line 1 of claim 20 because it is unclear. Applicant has amended claim 20 to delete any reference to the phrase "magic hand" and reconsideration is requested.

Cross-Reference to Related Applications

In addition, Applicant would like to bring the following copending U.S. applications to the Examiner's attention:

U.S. Application Serial No. 08/275,909 to Zhang (assigned to Semiconductor Energy Laboratory Co., Ltd.), filed on July 15, 1994 and entitled "METHOD OF ANNEALING A SEMICONDUCTOR."

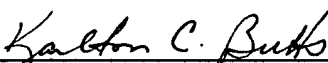
U.S. Application Serial No. 08/460,688 to Zhang (assigned to Semiconductor Energy Laboratory Co., Ltd.), filed on June 2, 1995 and entitled "METHOD OF ANNEALING A SEMICONDUCTOR."

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Conclusion

For the reasons set forth above, applicant now believes that claims 8, 11-13, and 15-25 are in proper condition for allowance. Reconsideration of the pending rejections, and examination of the newly submitted claims is requested. If any further discussion about this case would be beneficial, the Examiner is invited to contact the undersigned.

Respectfully submitted,



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